Efficient full field of view polarimetric calibration method for Simultaneous Imaging Polarimeter

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Polarimeters have widely been used to measure the polarization state of the light beam reflected by the object of interest. The Off-axis Three-mirror Simultaneous Imaging Polarimeter (OTSIP) is a kind of polarimetric remote sensor with high spatial resolution. In OTSIP, simultaneous measurements are performed by means of prism dividing amplitude. Due to various equipped polarizers and complex polarimetric characteristics of OTSIP, its instrument matrix will deviate from the ideal value. In order to ensure the polarimetric accuracy of OTSIP, the development of an efficient polarimetric calibration is indispensable. In this paper, a calibration method using a standard linear polarization light source and circular polarization light source was proposed. The first three columns of the instrument matrix were firstly calibrated by a linear polarimetric calibration source to obtain the calibration coefficients via the least-squares fitting algorithm, and then the fourth column of the instrument matrix was calibrated by a circular polarimetric calibration source. Moreover, the nonideality of circular polarization state light was significantly improved by averaging measured results at 0° and 90° azimuths, as the error caused by non-ideal of circular polarization was countervailed.

All the aforementioned calibration methods are applicable merely at single field of view. Therefore, it is crucially important to develop an appropriate polarimetric calibration method for ensuring high polarimetric accuracy at full field of view. As for the full field of view polarization calibration, a linear fitting method to each element of the instrument matrixes at multiple field of view angles was used. In order to verify the results of using OTSIP polarization calibration method in this paper, the polarimetric accuracy of OTSIP after calibration was verified by using the Adjustable Polarization Light Source (APLS) in the laboratory of Anhui Institute of Optics and Fine Mechanics. According to Fresnel's law, the polarization degree of the transmission light though APLS's two glass plates with high refractive index could be calculated. Required linear polarization light could be obtained by adjusting the inner glass plates to a specified angle. The standard circular polarization light source is formed by an integrating light source, a depolarizer, a Gran Taylor prism and a quarter wave plate. The quarter wave plate was mounted at 45° with respect to Glan Taylor prism's crystal optical axis. Each standard polarization degree at three field of view angles was compared with the OTSIP's measured calibrated results. The resulting polarimetric measurement accuracy showed that the linear and circular polarization measurement accuracy was better than 1% (at DOLP ≤ 0.3, or DOCP = 1), validating the effectiveness and feasibility of this polarimetric calibration method. This method greatly improves the calibration efficiency of the OTSIP, making it possible to calibrate the polarimeter in flight.

References

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